APPENDIX C

Brown & Caldwell's
Technical Memorandum
On

MBC CAMP- EQUIPMENT UPGRADE
AND EXPANSION

TECHNICAL MEMORANDUM

DATE: Wednesday, October 12, 2005

TO: REY SACRO, CITY OF SANDIEGO

FROM: VICTOR OCCIANO

SUBJECT: MBC CAMP – EQUIPMENT UPGRADES AND EXPANSION
(BC Job No. 124901 & 123653) – Revision 2

PURPOSE

The purpose of this study is to estimate the year when certain MBC facilities must be expanded or upgraded to accommodate the growth projected for the MWWD service area. A mass balance model contained in an MSExcel workbook (currently being used for master planning of MWWD facilities) was modified for the analysis.

The MBC facility improvements of interest, as listed in the *MBC UPGRADES PROJECTS 012805*, include the following:

- Project P-10.6 – Replace 4 Dewatering Centrifuges with Larger Capacity Units
- Project P-11.1 - Additional Biosolids Storage Silos
- Project P-11.6 – New Biosolids Truck Loadout Facility

METHODOLOGY

The step-by-step process instituted to arrive at the projected estimates is as follows:

1. **Collect influent and effluent flow, TBOD, and TSS information for PLWTP, NCWRP, SBWRP, and MBC –** The collected data was used to calibrate the mass balance model. The City initially provided Brown and Caldwell (BC) information for the noted facilities for calendar years 1999 to 2003, with only half-year data provided for 2001. The data showed that during 1999 and 2000 calendar years, the TSS and TBOD concentrations in the NCWRP return streams (i.e., wastewater from NCWRP that is returned to the sewers for eventually re-treatment at PLWTP) were

two orders of magnitude higher than what is currently observed. BC and City staff both decided to use data collected for 2001, 2002 and 2003 only for model calibration purposes.

2. **Determine Average, Minimum, Maximum, and 90th and 95th Percentile Values of the Collected Data** - In a meeting held between BC and City staff on March 25, 2005, it was decided to use the 95th percentile values of **7-day rolling averages** in calibrating models for Projects P-11.1 and P-11.6. The group felt that this provided enough margin of safety to ensure that sufficient treatment capacity existed. It was also decided to use the maximum daily values recorded between 2001 and 2003 in calibrating the model for determining upgrade needs of existing dewatering centrifuges, i.e., Project P-10.6. However, this proved to be an extremely high value which may result in ultra conservative output. Therefore, the model runs for evaluating dewatering centrifuges were calibrated based on the 95th percentile of **daily average** values for calibration and TSS and TBOD concentrations assumed for the influent and effluent streams. Data tables are provided in Attachment A.

3. **Calibrate Model –** Model parameters such as percent removal efficiencies for primary sedimentation process, capture efficiencies for thickening and dewatering processes were changed to match the 95th percentile effluent concentrations for daily and 7-day rolling averages.

4. **Determine Calendar Year When Capacities are Reached** – After establishing model parameters that result in closely matching 95th percentile of measured values, the model was run for future flows predicted for the service area at a given year. Flow projections were developed separately by the City using SANDAG population projections and unit generation rates established by the City. These projected flows are included in the workbook as a data base.

   The mass balance model is programmed to ask the model operator for a future calendar year that he/she would like to evaluate. The model then extracts the associated flow from the data base within the workbook and proceeds into an iteration phase until the flows and loads balance. Depending on the project, the amount of digested and dewatered solids is compared against available capacities. If the amount of solids production exceeds the capacity, a lower input year is entered and the iteration step is repeated. If not, a higher input year is entered. This process continues until the capacities and production rate closely match.

MODEL RESULTS

General key assumptions different from previous mass model runs, assumptions specific to each project borne from the calibration runs, and model results are discussed below. Copies of actual model runs are provided in Attachment B.

Revised General Key Assumptions

Revisions in assumptions contained in the original MS Excel workbook provided to Brown and Caldwell by the City (masmdl20a2.xls) are provided in Table 1. Parameters provided in the table were commonly used in all model runs for this project. Most changes were a result of suggestions by City staff intimately familiar with the operation of the facilities/plants indicated.

Table 1
Revisions to Previous Mass Balance Model Parameters
Common to all MBC CAMP Project Model Runs

Item	Old	New
Chemical Sludge Production, lb TSS / lb $FeCl_3$ Added (see Attachment C for backup calculation)	0.7	1.1
Capture of Chemical Sludge, %	95%	100%
Chemical Addition – ferric chloride, mg/L	40	30
Combined Sludge Specific Gravity	1.0	1.01
Thickened Sludge Specific Gravity	1.01	1.03
Combined Sludge VSS Destruction, %	45%	52%
Gas Production Rate, scf/lb VSS destroyed	15	14.5
Digester Influent to Effluent Ratio	1.0	0.99
Digested Sludge Specific Gravity	1.02	1.03
Solids Concentration of Dewatered Sludge, % (w/w)	30%	28%
Solids Recovery in Thickener, %	90%	97%
Thickened Sludge Solids Concentration, % (w/w)	3.0%	3.5%
NCWRP TSS Removal in Primaries	60%	65%
NCWRP TBOD Removal in Primaries	35%	38%
NCWRP Secondary MLTSS Concentration, mg/L	2800	2155
NCWRP MCRT, days	5	5.86
NCWRP $FeCl_3$ Addition, mg/L	15	10
$FeCl_3$ Solution Strength, %	40%	44%
$FeCl_3$ Solution Specific Gravity	1.31	1.467

For all MBC CAMP model runs, it was assumed that NCWRP and SBWRP were the only wastewater treatment plants in service and that they produce secondary effluent. The NCWRP effluent was assumed to be returned to the sewer for re-treatment at PLWTP and the SBWRP effluent was disposed through the South Bay Ocean Outfall. PLWTP is assumed to continue operating as an advanced primary treatment plant. Model runs were performed only up to the year 2025. At this time, the current Master Plan indicates that the Southern Sludge Processing Facility and a South Bay Secondary Treatment Plant will be in service. Solids from the SBWRP will then be processed at the new facility, relieving the MBC of the need to process these solids.

Project P-10.6 – Replace 4 Dewatering Centrifuges with Larger Capacity Units

Revisions made in the original Mass Balance model resulting from the calibration run for Project P-11.0 are presented in Table 2. Note that the calibration run was based on the 95^{th} percentile of **daily average** values for calendar year 2001-2003.

Table 2
Revisions Made in Previous Mass Balance Model for MBC CAMP Project P-11.0

Item	Old	New
TBOD Concentration - Total MSS, mg/L	284	317
TBOD Concentration – PQPS & NCWRP, mg/L	225	282
TBOD Concentration – SBWRP, mg/L	300	468
TSS Concentration - Total MSS, mg/L	293	296
TSS Concentration – PQPS & NCWRP, mg/L	225	278
TSS Concentration – SBWRP, mg/L	275	528
PLWTP Removal of MSS and Retreat TSS, %	86.3%	82.9%
PLWTP Removal of TSS in Recycle and Thickening & Dewatering Centrate, %	85%	82.9%
PLWTP Overall Removal of TBOD, %	60%	59.0%
Solids Recovery in Thickeners & Dewatering Centrifuges, %	95%	82.5%
NCWRP Secondary Effluent TSS Concentration, mg/L	9	5.7
NCWRP Secondary Effluent TBOD Concentration, mg/L	9	7.0
SBWRP Chemical Addition, mg/L	15	0
SBWRP Secondary Effluent TSS Concentration, mg/L	9	10.3
SBWRP Secondary Effluent TBOD Concentration, mg/L	9	23.4

Additional assumptions made regarding the dewatering centrifuges include the following:

- Six of the eight dewatering centrifuges are in operation (i.e., two are in standby mode at all times)
- Each existing centrifuge can process up to 225 gpm (average) or 300 gpm (peak) of digested sludge; average capacity was used in determining expansion needs
- 3.0% Solids content in digested sludge

Results

The existing dewatering centrifuges at MBC are adequate until the year 2025. Therefore, upgrade or expansion is unnecessary up to the planning horizon of for this evaluation study. Any modifications will be driven by the equipment useful lives.

<u>Project P-11.1 - Additional Biosolids Storage Silos</u>

Revisions made in the original mass balance model resulting from the calibration run for Projects P-11.1 and P-11.6 are reported in Table 3. Note that the calibration run was based on the 95th percentile of **7-day running average** values for calendar year 2001-2003.

Table 3
Revisions Made in Previous Mass Balance Model for MBC CAMP Project P-11.1 & P-11.6

Item	Old	New
TBOD Concentration - Total MSS, mg/L	284	300
TBOD Concentration – PQPS & NCWRP, mg/L	225	256
TBOD Concentration – SBWRP, mg/L	300	365
TSS Concentration - Total MSS, mg/L	293	273
TSS Concentration – PQPS & NCWRP, mg/L	225	272

Table 3
Revisions Made in Previous Mass Balance Model for MBC CAMP Project P-11.1 & P-11.6

Item	Old	New
TSS Concentration – SBWRP, mg/L	275	376
PLWTP Removal of MSS and Retreat TSS, %	86.3%	82.7%
PLWTP Removal of TSS in Recycle and Thickening & Dewatering Centrate, %	85%	82.7%
PLWTP Overall Removal of TBOD, %	60%	59.2%
Solids Recovery in Thickeners & Dewatering Centrifuges, %	95%	80%
NCWRP Secondary Effluent TSS Concentration, mg/L	9	4.9
NCWRP Secondary Effluent TBOD Concentration, mg/L	9	5.9
SBWRP Chemical Addition, mg/L	15	0
SBWRP Secondary Effluent TSS Concentration, mg/L	9	7.7
SBWRP Secondary Effluent TBOD Concentration, mg/L	9	9.8

Additional assumptions made specific to the operation of the existing silos that impact capacity estimates include the following:

- Dewatering centrifuges produce a dewatered cake that is 28% solids
- Maximum storage capacity required is equivalent to the amount of dewatered cake produced in 2.63 or 3.63 days, i.e., two scenarios were evaluated
- One or two silos were out of service (again, two scenarios were evaluated)
- Each silo has a maximum storage capacity of 6,950 ft^3, however, only 90% of the volume can be used on a daily basis

Results

The required upgrades are summarized in Table 4 below.

Table 4
Recommended Startup Year for MBC CAMP Silo Upgrades Under Various Scenarios

Scenario		Recommended Startup Year[(a)]
Storage Provided (days)	Number in Operation	
3.63	6 out of 8	Capacity Currently Exceeded
3.63	8 out of 8	Capacity Currently Exceeded
2.63	7 out of 8	2014
3.63	10 out of 12	2017
2.63	8 out of 10	Beyond 2025
3.63	11 out of 13	Beyond 2025

(a) Indicates when capacity of the operating silos noted is exceeded and startup of new silos required.

The storage time requirement was determined as follows:

Table 5
Determination of Maximum Downtime for Silos for Estimating Required Capacity
(Holiday Falls on Friday)

<table>
<tr><th rowspan="2">Condition</th><th colspan="6">Hours of Downtime for Silos</th><th rowspan="2">Total (Days)</th></tr>
<tr><th>Thursday (stop at 15:00)</th><th>Friday (HOLIDAY)</th><th colspan="2">Sat</th><th>Sun</th><th>Mon (start at 06:00)</th></tr>
<tr><td>No work on Sat. & Holiday</td><td>9</td><td>24</td><td colspan="2">24</td><td>24</td><td>6</td><td>87/24 = 3.63 d</td></tr>
<tr><td>Work on Saturday</td><td>9</td><td>24</td><td>6</td><td>9</td><td>24</td><td>6</td><td>Max down time 39/24 = 1.63 d</td></tr>
</table>

Table 6
Determination of Maximum Downtime for Silos for Estimating Required Capacity
(Holiday Falls on Monday)

Condition	Hours of Downtime for Silos					Total (Days)
	Friday (stop at 15:00)	Sat	Sun	Mon (HOLIDAY)	Tues (start at 06:00)	
No work on Sat. & Holiday	9	24	24	24	6	87/24 = 3.63 d
Work on Saturday		9	24	24	6	Max down time 63/24 = 2.63 d

The 2.63 days of storage assumes two days of down time (i.e., weekend day plus a Monday holiday) plus 15 hours between shutdown and startup. This was selected for determination of required silo capacity because it represented the worst-case scenario for a holiday event that includes a Saturday workday. The 3.63 days of storage requirement assumes that the facility is closed on Saturdays.

If only one silo is required for back up (i.e., 7 of the existing 8 silos are in operation) and if 2.63 days of storage must be provided, the existing silos provide adequate capacity until 2014. However, if 3.63 days of storage is required, four additional silos would be required to provide capacity up to year 2017. Furthermore, to provide sufficient capacity beyond year 2025 (when the southern sludge processing facility will be in service) with two units in standby, two silos must be constructed under the 2.63 days of storage scenario or five silos (for a total of 13 silos) if 3.63 days of storage is required.

Project P-11.6 – New Biosolids Truck Loadout Facility

Model revisions shown in Table 3 are valid for Project P-11.6 as well since this MBC project also uses the 95th percentile of 7-day averages for calibration. Additional assumptions specifically related to the Truck Loadout Facility include the following:

- Each bay has the capacity to hold 648 ft^3 of dewatered sludge per load
- Two bays are available at all times
- Each truck requires 25 minutes drive in, accept a load, and drive out
- Cake pumps are capable of transferring biosolids from the silos to the truck loadout within the assumed loading duration noted above
- Bays are only open 5 or 6 days per week and 8 or more hours per day (various scenarios evaluated as indicated in Table 7)
- Truck loadout opens one hour extra than the hours indicated on Table 7 to account for startup and cleanup time at the beginning and end of each work day

Results

The required upgrades are summarized in Table 7 below.

Table 7
Recommended Startup Year for MBC CAMP Truck Loadout Upgrades Under Various Scenarios

Loadout Operation		Recommended Startup Year(b)
Number of Days per Week	Number Hours per Day(a)	
5	8	2014
6	8	Beyond 2025
5	9.1	Beyond 2025

(a) Hours indicated represents actual operating hours of the loadout facility. Building opens one hour extra to account for startup and cleanup at the beginning and end of each work day. Work period exceeding eight hours may require special agreement with the landfill operator.
(b) Indicates when capacity of the operating units noted is exceeded and startup of new units required.

At 5 days per week operation and 8 hours per day, two truck loadout bays are adequate until 2014. If the City chooses to operate on Saturdays, the existing bays are adequate beyond the year 2025. This can also be achieved without operating on Saturdays by simply allowing loadout operations to continue for a little over 9 hours per day for five days a week (work period exceeding eight hours may require special agreement with the landfill operator).

CONCLUSION/RECOMMENDATIONS

Recommended startup years for the MBC expansion projects are provided in Table 8 under various scenarios for each project.

Table 8
Recommended Startup Year for MBC CAMP Projects

Project Number, Name and Scenarios	Recommended Startup Year[a]
P-10.6 – Replace 4 Dewatering Centrifuges with Larger Capacity Units	Beyond 2025
P-11.1 – Additional Biosolids Storage Silos	
• 3.63 days storage; 6 of 8 in Operation	• Currently Exceeds Capacity
• 3.63 days storage; 8 of 8 in Operation	• Currently Exceeds Capacity
• 2.63 days storage; 7 of 8 in Operation	• 2014
• 3.63 days storage; 10 of 12 in Operation – Expansion has Occurred	• 2017
• 2.63 days storage; 8 of 10 in Operation – Expansion has Occurred	• Beyond 2025
• 3.63 days storage; 11 of 13 in Operation – Expansion has Occurred	• Beyond 2025
P-11.6 – New Biosolids Truck Loadout Facility	
• 2 Bays in Operation; 5 days/week; 8 hours/day	• 2014
• 2 Bays in Operation; 6 days/week; 8 hours/day	• Beyond 2025
• 2 Bays in Operation; 5 days/week; 9.1 hours/day	• Beyond 2025

(a) Indicates when capacity of the operating units noted is exceeded and startup of new units required.

Since additional data can improve the accuracy of the model, follow-up model runs are recommended when more data are available.

cc: Pete Wong — City of San Diego MWWD
Amer Barhoumi — City of San Diego MWWD
Monika Smoczynski — City of San Diego MWWD
Guann Hwang — City of San Diego MWWD
File